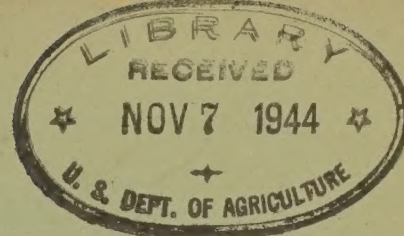


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United States Department of Agriculture



AGRICULTURAL NOTES

NO. 78 PAGE I

MAYAGUEZ, P. R. JUNE 14, 1937

THE INTRODUCTION AND COLONIZATION IN PUERTO RICO OF
BENEFICIAL INSECTS PARASITIC ON THE SUGARCANE MOTH BORER

BY

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THE MOTH BORER IS THE MOST IMPORTANT INSECT OF SUGARCANE IN THE WESTERN
HEMISPHERE.

THE SUGARCANE MOTH BORER, DIATRAEA SACCHARALIS, IS THE MOST IMPORTANT SUGARCANE PEST IN PUERTO RICO AND PROBABLY IN THE WHOLE WESTERN HEMISPHERE. FORTUNATELY ONLY ONE SPECIES IS FOUND IN PUERTO RICO AS CONTRASTED WITH THE OTHER ISLANDS OF THE WEST INDIES WHERE SEVERAL SPECIES ARE PRESENT. THE DAMAGE CAUSED BY THIS INSECT IS VERY DIFFICULT TO DETERMINE ACCURATELY, AND THE ESTIMATES MADE BY VARIOUS WORKERS DIFFER GREATLY. IT MAY SUFFICE TO SAY THAT THE DAMAGE CAUSED BY THIS INSECT DIRECTLY BY FEEDING, TUNNELING, AND KILLING OF YOUNG SHOOTS PLUS THAT OCCASIONED INDIRECTLY FROM FUNGI THAT CAUSE IMPURITIES AND INTERFERE IN THE RECOVERY OF SUCROSE HAS INDUCED GOVERNMENTS AND PRIVATE INDUSTRY TO SPEND THOUSANDS OF DOLLARS UPON CONTROL MEASURES.

THE NOTES WHICH FOLLOW ARE A SUMMARY OF THE PROGRAM OF BIOLOGICAL CONTROL INITIATED BY THE BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE OF THE UNITED STATES DEPARTMENT OF AGRICULTURE AGAINST THIS PEST IN PUERTO RICO. THE RECORDS AND STUDIES WERE MADE BY THE AUTHOR FROM JULY 1935 TO OCTOBER 1936. THE WRITER WISHES TO EXPRESS APPRECIATION FOR THE SPIRIT OF COOPERATION SHOWN BY THE VARIOUS SUGAR CENTRALS WITH

/A NOW ASSOCIATE ENTOMOLOGIST, PUERTO RICO EXPERIMENT STATION, UNITED STATES DEPARTMENT OF AGRICULTURE.

REPORT OF THE
ENTOMOLOGICAL COMMISSION
ON THE
RESULTS OF THE
ENTOMOLOGICAL SURVEY OF
THE UNITED STATES

The following is a summary of the results of the entomological survey of the United States, as conducted by the Entomological Commission, under the direction of the Secretary of Agriculture, during the years 1901 and 1902. The survey was conducted in accordance with the plan adopted by the Commission, and the results are presented in this report. The survey was conducted in accordance with the plan adopted by the Commission, and the results are presented in this report.

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WHOM CONTACTS HAVE BEEN MADE. HE WISHES ESPECIALLY TO THANK MR. JUAN VEVE OF CENTRAL FAJARDO EXPERIMENT STATION, AND MR. O. D. PROVERBS OF RUSSELL AND COMPANY, HORMIGUEROS DIVISION, FOR GIVING FREELY OF THEIR TIME AND HELP WITH THIS PROBLEM.

THE MOTH BORER KILLS YOUNG PLANTS AND WEAKENS OLDER PLANTS.

THE ADULT MOTH OF DIATRAEA SACCHARALIS LAYS ITS EGGS IN CLUSTERS ON THE UNDER SIDE OF THE CANE LEAVES. AT THE TIME OF HATCHING THE YOUNG LARVA MAY FEED ON THE MIDRIB AND BLADE OF THE LEAF BUT SHORTLY THEREAFTER IT ENTERS THE LEAF SHEATH AND BURROWS INTO THE STALK. IN THE CASE OF YOUNG PLANTS THE CENTRAL SHOOT IS THE PART ATTACKED, THE CENTRAL WHORL OF LEAVES DIES, AND THE INJURY RESULTING IS COMMONLY KNOWN AS "DEAD-HEARTS." WHEN OLDER CANE IS ATTACKED, THE BORER TUNNELS THROUGHOUT THE STALK AND AT TIMES HORIZONTALLY ABOUT THE NODE. ALL OF THIS WEAKENS THE PLANT. THE LARVA CHANGES TO A PUPA IN THE STALK NEAR THE OUTER END OF AN ENLARGED PARTIALLY COMPLETED TUNNEL THINLY SEALED WITH SILK BY THE LARVA. JUST PRIOR TO EMERGENCE THE PUPA BREAKS THIS SEAL AND THE MOTH EMERGES UNHINDERED TO START ANOTHER GENERATION OF EGGS AND LARVAE.

PARASITES IMPORTED FOR USE AGAINST THE SUGARCANE MOTH BORER.

IN A RECENT ARTICLE IN THIS SERIES MR. S. M. DOHANIAN HAS GIVEN AN ACCOUNT OF HIS EXPLORATORY WORK IN THE BRITISH WEST INDIES, BRITISH GUIANA, AND PERU FOR NATURAL ENEMIES OF THIS SUGARCANE MOTH BORER AND OTHER PESTS. AS A RESULT OF THIS WORK AND OF A SHIPMENT FROM THE UNITED STATES THE PARASITES LISTED IN TABLE 1 WERE RECEIVED.

TABLE 1.--IMPORTATIONS OF SUGARCANE MOTH BORER PARASITES INTO PUERTO RICO, SHOWING SPECIES, COUNTRY OF ORIGIN, NUMBER OF SHIPMENTS, AND NUMBER OF PARASITES RECEIVED ALIVE

SPECIES	COUNTRY OF ORIGIN	NUMBER OF SHIPMENTS	NUMBER PARASITES RECEIVED ALIVE
<u>BASSUS STIGMATERUS</u>	BRITISH GUIANA	3	61
<u>IPOBRACON RIMAC</u>	PERU	7	7,892
<u>LYDELLA STABULANS</u> VAR. <u>GRISESCENS</u>	U. S. A.	1	2,072
<u>METAGONISTYLUM MINENSE</u>	BRITISH GUIANA	10	5,823
<u>PARATHERESIA CLARIPALPIS</u>	PERU	7	557
<u>STOMATODEXIA DIADEMA</u>	BRITISH GUIANA	2	8
TOTAL			16,413

LYDELLA STABULANS VAR. GRISESCENS IS A PARASITE OF THE EUROPEAN CORN BORER ESTABLISHED IN THE UNITED STATES THROUGH IMPORTATIONS FROM THE ORIENT. OWING TO THE SIMILARITY OF THE CORN BORER TO THE CANE BORER IT WAS THOUGHT THAT THE CORN BORER PARASITE MIGHT BE USEFUL AGAINST THE SUGARCANE MOTH BORER, AND CONSEQUENTLY ARRANGEMENTS WERE MADE TO SECURE IT. THE MATERIAL WAS REARED BY C. A. CLARK, OF THE EUROPEAN CORN BORER LABORATORY OF THE BUREAU AT MOORESTOWN, N. J., AND SHIPPED IN THE ADULT STAGE BY AIRPLANE TO PUERTO RICO.

BRIEF OUTLINES OF THE LIFE HISTORY OF THE PARASITES OF THE SUGARCANE MOTH BORER.

FOUR OF THE INTRODUCED SPECIES, LYDELLA STABULANS VAR. GRISESCENS, METAGONISTYLUM MINENSE, PARATHERESIA CLARIPALPIS, AND STOMATODEXIA DIADEMA BELONG TO THE ORDER OF INSECTS KNOWN AS DIPTERA, AND ARE SIMILAR IN APPEARANCE TO OUR COMMON TWO-WINGED FLIES. THE OTHER TWO SPECIES, BASSUS STIGMATERUS AND IPOBRACON RIMAC, ARE OF THE ORDER HYMENOPTERA AND ARE WASPLIKE IN APPEARANCE.

THE DIPTEROUS PARASITES ARE SIMILAR IN HABIT. THEY GIVE BIRTH TO SMALL LIVING MAGGOTS WHICH ARE USUALLY LAID AT OR NEAR THE ENTRANCE HOLE MADE BY THE DIATRAEA LARVAE, AND THE YOUNG PARASITE LARVA ENTERS THE TUNNEL IN SEARCH OF THE BORER, ITS HOST. WHEN IT FINDS THE BORER, THE YOUNG PARASITE LARVA PENETRATES THE INTEGUMENT OR SKIN OF THE BORER AND BECOMES AN INTERNAL FEEDER WITHIN THE BORER'S BODY. AFTER SOME DAYS OF FEEDING ON THE VITAL ORGANS OF THE BORER THE PARASITE LARVA KILLS ITS HOST, AND THEN EMERGES, LEAVING THE HOST REMAINS. THE FULL-GROWN PARASITE LARVA PUPATES AND FORMS A SMALL BROWN PUPARIUM FROM WHICH IN A FEW DAYS THE ADULT FLY EMERGES AND CONTINUES ITS ATTACK ON OTHER BORERS.

THE TWO HYMENOPTEROUS PARASITES DIFFER IN THEIR LIFE HISTORY. BASSUS STIGMATERUS SEEKS OUT THE HOST LARVA AND DEPOSITS AN EGG WITHIN ITS BODY. THE YOUNG PARASITE LARVA HATCHES AND PROCEEDS TO CONSUME THE HOST LARVA UNTIL FULLY FED, WHEREUPON IT EMERGES FROM ITS HOST. THE PARASITE LARVA THEN SPINS A VERY DELICATE SILK COCOON, AND FROM THIS THE ADULT LATER EMERGES.

IPOBRACON RIMAC IS AN EXTERNAL PARASITE, AND THE FEMALE PARALYZES THE HOST LARVA BY STINGING IT. THE EGG IS LAID ON THE OUTSIDE OF THE BODY OF THE HOST, AND THE LARVA FEEDS EXTERNALLY THROUGHOUT ITS DEVELOPMENT. WHEN FULLY DEVELOPED THE PARASITE LARVA SPINS A COCOON, AND FROM THIS THE ADULT LATER EMERGES.

THE AMAZON FLY HAS BEEN REARED IN PUERTO RICO IN THE LABORATORY.

IT WAS ORIGINALLY PLANNED TO REAR THE AMAZON FLY, METAGONISTYLUM MINENSE, ON AN EXTENSIVE SCALE IN ORDER TO SUPPLEMENT FIELD LIBERATIONS OF THE MATERIAL ORIGINALLY SHIPPED TO PUERTO RICO. UNFORTUNATELY THE PROGRAM WAS UNAVOIDABLY INTERRUPTED BY A QUESTION AS TO THE AVAILABILITY OF FUNDS; THE BREEDING WORK WAS NECESSARILY CURTAILED UNTIL OTHER FUNDS WERE PROVIDED, AND DURING THIS PERIOD AN UNFORTUNATE ACCIDENT RESULTED IN THE LOSS OF THE SMALL BREEDING STOCK THAT WAS BEING MAINTAINED FOR THIS WORK.

THE AMAZON FLY WAS READILY REARED IN THE LABORATORY BY FOLLOWING THE TECHNIQUE USED BY S. M. DOHANIAN IN BRITISH GUIANA AND ADAPTED FROM THAT PREVIOUSLY USED BY THE ENTOMOLOGISTS OF THAT COUNTRY. SOME INNOVATIONS TO SUIT LOCAL CONDITIONS AND EQUIPMENT WERE TRIED BUT REACHED ONLY THE EXPERIMENTAL STAGE BEFORE THE PROGRAM WAS CURTAILED. THE

PROCEDURE USED CAN BE BRIEFLY OUTLINED AS FOLLOWS: A FEMALE PARASITE WHICH WAS KNOWN TO BE FERTILE WAS DISSECTED AND THE OVARIES REMOVED AND PLACED IN A WEAK SALINE SOLUTION. THE YOUNG MAGGOTS WERE ALLOWED TO ESCAPE GRADUALLY INTO THE SOLUTION THROUGH PUNCTURES MADE IN THE OVARIES WITH A NEEDLE. THE LARVA OF DIATRAEA SACCHARALIS WAS DIPPED IN A SALINE SOLUTION AND A PARASITE LARVA THEN PLACED UPON IT BY MEANS OF A CAMEL'S-HAIR BRUSH. FOLLOWING THIS THE HOST LARVA WAS PLACED IN A TIN SALVE BOX FOR A FEW HOURS TO ALLOW THE PARASITE LARVA TO PENETRATE THE INTEGUMENT WITHOUT DANGER OF BEING RUBBED OFF, AND FINALLY PLACED UPON A CANE STALK FOR FURTHER FEEDING. AT THE END OF ABOUT 12 DAYS THE PARASITE HAD COMPLETED ITS FEEDING WITHIN THE HOST LARVA AND HAD EMERGED AND FORMED A PUPARIUM, AND FROM THIS THE ADULT PARASITE EMERGED. DURING THIS BREEDING PROGRAM 2,328 LARVAE OF D. SACCHARALIS WERE INOCULATED, 949 PUPARIA OF METAGONISTYLUM MINENSE WERE RECOVERED, AND 804 FLIES EMERGED.

BENEFICIAL SPECIES WERE LIBERATED IN PUERTO RICO TO AID IN THE CONTROL OF THE MOTH BORER.

THE SELECTION OF POINTS FOR THE LIBERATION OF THE SPECIES OF PARASITES INTRODUCED INTO THE ISLAND WAS BASED LARGELY ON INFORMATION SUBMITTED BY S. M. DOHANIAN AS TO THE TYPE OF ENVIRONMENT UNDER WHICH HE FOUND THESE BENEFICIAL INSECTS PROPAGATING IN THEIR NATIVE HABITAT. THE AMAZON FLY IS ADAPTED TO WET AND EVEN SWAMPY CONDITIONS, WHEREAS THE TWO SPECIES FROM PERU WERE FOUND IN A SEMIARID AREA. THE SPECIES WERE ACCORDINGLY DISTRIBUTED LARGELY IN THE NORTHEASTERN CORNER OF THE ISLAND AND ON THE SOUTH COAST. TABLE 2 GIVES THE POINTS WHERE LIBERATIONS WERE MADE AND THE SPECIES AND NUMBER OF INDIVIDUALS LIBERATED. ALL OF THE SPECIES WERE LIBERATED IN THE ADULT STAGE.

TABLE 2.— THE LIBERATIONS IN PUERTO RICO DURING 1935-36 OF INSECT SPECIES PARASITIC ON THE SUGARCANE BORER, SHOWING DATES, LOCALITIES, AND THE NUMBER LIBERATED

LIBERATION POINTS AND DATES	NUMBER OF INDIVIDUAL SPECIES OF SUGARCANE BORER PARASITES LIBERATED						TOTAL NUMBER OF INDIVIDUAL PARASITES LIBERATED
	<u>BASSUS</u> <u>STIGMATERUS</u>	<u>IPROBACON</u> <u>RIMAC</u>	<u>LYDELLA</u> <u>STABULANS</u> VAR. <u>GRISESCENS</u>	<u>METAGONISTYLUM</u> <u>MINENSE</u>	<u>PARATHERESIA</u> <u>CLARIPALPIS</u>	<u>STOMATODEXIA</u> <u>DIADEMA</u>	
INSULAR ROAD BETWEEN RIO PIEDRAS AND TRUJILLO ALTO, KM. 1.4, DEC. 23, 1935				429			429
CENTRAL VICTORIA, INSULAR ROAD NO. 3, KM. 5.5, NORTH 1.5 KM., DEC. 16, 1935	61			835			896

(CONTINUED)

LIBERATION POINTS AND DATES	NUMBER OF INDIVIDUAL SPECIES OF SUGARCANE BORER PARASITES LIBERATED						TOTAL NUMBER OF INDIVIDUAL PARA- SITES LIBERATED
	<u>BASSUS</u> <u>STIGMATERUS</u>	<u>I</u> <u>P</u> <u>R</u> <u>O</u> <u>B</u> <u>R</u> <u>A</u> <u>C</u> <u>O</u> <u>N</u> <u>I</u> <u>M</u> <u>A</u> <u>C</u>	<u>LYDELLA</u> <u>STABULANS</u> <u>VAR.</u> <u>GRISESCENS</u>	<u>M</u> <u>E</u> <u>T</u> <u>A</u> <u>G</u> <u>O</u> <u>N</u> <u>I</u> <u>S</u> <u>T</u> <u>Y</u> <u>L</u> <u>U</u> <u>M</u> <u>M</u> <u>I</u> <u>N</u> <u>E</u> <u>N</u> <u>S</u> <u>E</u>	<u>P</u> <u>A</u> <u>R</u> <u>A</u> <u>T</u> <u>H</u> <u>E</u> <u>R</u> <u>E</u> <u>S</u> <u>I</u> <u>A</u> <u>C</u> <u>L</u> <u>A</u> <u>R</u> <u>I</u> <u>P</u> <u>A</u> <u>L</u> <u>P</u> <u>I</u> <u>S</u>	<u>S</u> <u>T</u> <u>O</u> <u>M</u> <u>A</u> <u>T</u> <u>O</u> <u>D</u> <u>E</u> <u>X</u> <u>I</u> <u>A</u> <u>D</u> <u>I</u> <u>A</u> <u>D</u> <u>E</u> <u>M</u> <u>A</u>	
CAROLINA, INSULAR ROAD NO. 3, KM. 16, NORTH 6 KM., NOV. 28, 1935				546		5	551
CENTRAL CANOVANAS, HACIENDA GRANDE, INSULAR ROAD NO. 3, KM. 18.0, EAST 2 KM., NOV. 28, 1935				581			581
RIO GRANDE, INSULAR ROAD NO. 3, KM. 24.0, NORTH 1 KM., NOV. 7, 1935				368			368
RIO GRANDE, INSULAR ROAD NO. 3, KM. 27.4, NORTH 3 KM., NOV. 19, 1935				522			522
FAJARDO, INSULAR ROAD NO. 3, KM. 41.7, NORTH 1.5 KM., DEC. 3, 1935				526		3	529
FAJARDO, INSULAR ROAD NO. 3, KM. 51.7, NORTH 1 KM., OCT. 30 AND DEC. 10, 1935				536			536
CEJIBA, INSULAR ROAD NO. 3, KM. 64.9, NORTH 2 KM., NOV. 12, 1935				618			618
NAGUADO PLAYA, INSULAR ROAD NO. 3, KM. 69.1, NORTH 1 KM., DEC. 10, 1935				578			578

(CONTINUED)

LIBERATION POINTS AND DATES	NUMBER OF INDIVIDUAL SPECIES OF SUGARCANE BORER PARASITES LIBERATED						TOTAL NUMBER OF INDIVIDUAL PARASITES LIBERATED
	<u>BASSUS STIGMATERUS</u>	<u>IPROBRACON RIMAC</u>	<u>LYDELLA STABULANS</u> VAR. <u>GRISESCENS</u>	<u>METAGONISTYLUM MINENSE</u>	<u>PARATHERESIA CLARIPALPIS</u>	<u>STOMATODEXIA DIADEMA</u>	
HORMIGUEROS, INSULAR ROAD NO. 29, KM. 7.0, NORTH 1 KM., DEC. 28, 1935 THROUGH JAN. 31, 1936				693			693
AÑASCO, INSULAR ROAD NO. 2, KM. 177.7, JAN., 1936				185			185
AGUIRRE, INSULAR ROAD NO. 3, KM. 147.8, MAY 10, 1936		518					518
CENTRAL AGUIRRE, INSULAR ROAD NO. 3, KM. 156.8, MAY 13, 1936		529					529
COLONIA TEXIDOR, DUSTINO FIELD, INSULAR ROAD NO. 3, KM. 171.2, MAY 13, 1936		706					706
CENTRAL CORTADA, PUMP VIA, INSULAR ROAD NO. 3, KM. 181.0, MAY 3 TO MAY 29, 1936		641			513		1,154
CENTRAL CORTADA, CINTRONA FIELD, INSULAR ROAD NO. 3, KM. 184.6, MAY 3 AND MAY 10, 1936		1,025					1,025

(CONTINUED)

LIBERATION POINTS AND DATES	NUMBER OF INDIVIDUAL SPECIES OF SUGARCANE BORER PARASITES LIBERATED						TOTAL NUMBER OF INDIVIDUAL PARA- SITES LIBERATED
	<u>BASSUS STIGMATERUS</u>	<u>I PROBRACON RIMAC</u>	<u>LYDELLA STABULANS</u> VAR. <u>GRISESCENS</u>	<u>METAGONISTYLUM MINENSE</u>	<u>PARATHERESIA CLARIPALPIS</u>	<u>STOMATODEXIA DIADEMA</u>	
CENTRAL MERCEDITA, LAUREL FIELD NO. 54, INSULAR ROAD NO. 3, KM. 195.0, MAY 13, 1936		535					535
CENTRAL MERCEDITA, FINCA UNION, INSULAR ROAD NO. 3, KM. 192.9, MAY 24, 1936		486					486
PONCE, RUSSELL & CO., HACIENDA REPARADA, PUNYON TABLON FIELD, INSULAR ROAD NO. 1, KM. 134.5, MAY 20, 1936		1,253					1,253
GUANICA, RUSSELL & CO., HA- CIENDA SANTA RITA, INSULAR ROAD NO. 39, KM. 32.3, MAY 24, 1936		1,488	408				1,896
GUANICA, RUSSELL & CO., HA- CIENDA SANTA RITA, INSULAR ROAD NO. 39, KM. 29.2, MAY 29, 1936		711					711
ARECIBO, INSULAR ROAD NO. 2, KM. 95.2, JULY 1, 1936			910				910
ISABELA, INSULAR ROAD NO. 2, KM. 134.7 JULY 1, 1936			754				754
TOTAL	61	7,892	2,072	6,417	513	8	16,963

